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STATIONARY ACCU BATTERIES FOR UNINTERRUPTED POWER SUPPLY SYSTEM OF THE POWER FACILITIES

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Abstract: Main issue in this paper work are different kind of batteries, their characteristics and maintenance methods. A special review of the accu batteries is given, and the results of the examination of the accu battery are given. Analyses of the results confirmed necessity of regular examination of battery, witch are system of uninterrupted supplies.

Keywords: *Battery, uninterrupted power supply, NiCd, measurement.*

1. INTRODUCTION

Batteries are electrochemical power sources that release energy in a controlled manner. Electricity to direct current is converted into chemical energy (charge), which is stored in the battery and connecting consumers chemical energy is converted into electricity (discharge). The battery has one or more cells connected in series constitute a battery accumulative. Each cell has a positive and negative electrodes immersed in an electrolyte.

2. TYPES OF ACCU BATTERIES AND FEATURES

According purpose can be:

1. Stationary batteries - for uninterrupted power supply systems, mostly lead, Fig. 1
2. Starter batteries - for bringing vehicles Fig. 2
3. Traction batteries Fig. 3 - to drive forklifts, mine locomotives, electric. vehicles etc.
4. Sealed batteries - Hermetically sealed, do not require any maintenance and used in rooms where it is not allowed evaporation of electrolyte, rooms in the presence of people. Used in small UPS systems for computers, torches, small cars and so on. (Type FG, SLA) Fig. 4.

Fig. 1 Stationary batteries

Fig. 2 Starter batteries

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Fig. 3 Traction batteries

Fig. 4 Sealed batteries

2.1. LEAD-ACID BATTERIES

Commonly are used for stationary use consist of a series of single cells with a nominal voltage of 2V or mono block batteries with 3 and 6 cells, where voltages are 6V or 12V. Performed as stationary batteries in a single array and batteries in series have additional cells (accessory) that are typically 10% of the number of cells in the main series. This provides further provided backup voltage automatically used be included in a voltage drop below the minimum allowable value.

Basic elements of accu battery:

- Positive electrode (lead-superoxide PbO_2)
- A negative electrode (pure porous lead Pb)
- Electrolyte (diluted sulphuric acid H_2SO_4)
- Separator (insulator which is set between the positive and negative plate, porous to allow passage of electrons from one to another).

Nominal voltage per cell 2V. Highest voltage charging 2,65 V per cell. The lowest voltage of discharge:

- 1,75V per cell, the discharge time of 1 – 3 h,
- 1,80V per cell, the discharge time of 3 -10 h,
- 1,90V per cell, with discharges exceeding 10 h.

Concentration of the electrolyte: In full battery 1,240 ± 0,01 g/cm^3, be it with an empty battery 1,150 g/cm^3.

- Ah usefulness: Ah transmitted / received Ah = 0,85 / 0,95,
- kWh usefulness: delivered kWh / received kWh = 0,75,
- for 3 to 10 h discharge, a = 0.70 for 1 h discharge.

The capacity of the stationary accu batteries is 7.5 to 14 Ah / dm^3 of the positive plate (excluding the surface from only one side).

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Fig. 5 Lead acid battery

2.2. NiCd (NICKEL CADMIUM) BATTERIES

Nickel cadmium batteries are quite expensive in terms of lead and are considered more reliable and require less maintence. In aspect of environmental protection NiCd batteries less polluting than lead acid batteries. Emissions of vapors in the mode of discharging and charging are smaller than emissions from lead acid batteries.
Key elements of the alkali (NiCd) batteries are:

- Positive electrode (nickel oxide hydroxide- NiO(OH))
- A negative electrode (cadmium in the form of powder – metallic Cd)
- Electrolytes (potassium hydroxide -KOH)
- Nominal voltage per cell 1,2V

Fig. 6 NiCd battery

3. APPLICATION OF STATIONARY ACCU BATTERIES

Solid-state accu batteries according leaning reserve power source in power plants. They are connected to the busbar of DC auxiliary voltage parallel with rectifier, which is powered by an AC voltage network or transformer for domestic consumption in the plant. In the presence of AC voltage batteries are in a constant recharge and consumers are powered by the rectifier. Upon failure of intermittent power to the rectifier, accumulator battery automatically takes power supply ensuring continuity.
In the last 20 years has a great technological advances in the production of batteries of following the trend of rapid development of sophisticated electronic devices, equipment and

mobile telecommunications. For these needs commonly used dry solid-state batteries Li + (Li-Ion), Li-polymer (Ly-poly), Li-copolymer (Li-ion-poly) and NiMH (nickel-metal-hydride), which use squeezed out NiCd and sealed lead acid batteries. But for stationary applications where a rule batteries are with high capacity (from a few dozen to several thousand Ah), for commercial use commonly used lead acid, and less NiCd batteries.
Generally, accu batteries are with different life cycle. The main parameters that have a special impact on are:

- Ambient temperature
- The number of cycles - charge - discharge
- Voltage charging
- Alternating current component of the charge- maintenance
- Deformation of the positive electrode corrosion
- Carbonation
- Memory effect

Different batteries differently submitted harmful influences. For optimum battery used, it is necessary to provide the appropriate conditions, adequate room ventilation, air conditioning.

4. PRINCIPLE AND PROCEDURE FOR CAPACITIVE TEST OF STATIONARY ACCU BATTERY

1. First connect mobile battery in parallel and solid-state battery is disconnected from the rectifier and the system of DC line and while capacitive probe is underway, consumers are supplied by mobile backup battery.
2. The battery is connected to the emptying device and connects each part individually. According to the type of battery, voltage level and capacity, with relevant technical parameters is defined end voltage per cell and discharge current. This current during the whole procedure should be constant as recommended by the manufacturer and the technical norms. Than the process of capacitive discharge can begin.
3. During the capacitive sample parameters are measured and recorded:
    - Voltage of each cell individually every hour and after 4 hours for every 15 min.
    - Concentration of electrolyte - before start and after completion of the sample (to the batteries with liquid electrolyte)
    - The temperature of the electrolyte (the batteries with liquid electrolyte)Voltage charging
4. After realization of capacitive sample solid-state battery in no circumstances be left empty long time. Battery immediately connected to the rectifier and is accessed by floadcherged with UI characteristic to voltage of 2,4 V/cell, after which the rectifier automatically switchover to operating mode of constant maintaining voltage of 2,23 - 2,25 V/cell. The regime of rapid charging (includes manual and only in the presence of the operator) to 2,65 V/cell can be applied only if the battery is disconnected from the DC system when no consumers connected DC system.

The determined capacity of the battery expressed in Ah is product of the discharge current Idischarge (A) and the discharge time t (h).

5. BATTERY MONITORING AND REVITALIZATION DEVICES

Nowadays, as a result of the great development of the technique and gained positive experiences and knowledge, there are sophisticated devices and complete systems of expertise and revitalization of stationary rechargeable batteries. The following example will show an examination with expertise system. This system is an innovation in the process of testing, developing, manufacturing and servicing the battery pack.

The system provides a fully automated process of examination for all types of batteries. Constructively, the system is portable (approx. 30 kg), with a powerful rectifier (16 kW to 44 kW) and constant discharge currents from 1 A to 400 A.

Fig. 7 System for measuring and monitoring of batteries

1. Deep discharge of cells with constant current,
2. Continuous diagram measurement and recording
   - Internal resistance per cell
   - Voltage per cell in different modes
   - Cell electrolyte concentration
3. Continuous measurement and recording graphs
   - Transient resistance of cell interfaces and pole extracts
   - Transient resistance of copper conductors-battery

5.1. MEASUREMENT AND BATTERY DATA

Battery:	BT2-BAT2-48
Type of cell:	3-PAS-O-246
Electrolyte temperature	20
Manufacturer:	Trepca
Number of cells:	23
Rated capacity	165Ah
Empty cell voltage	1.83V
Electrolyte density at 20°C	1.24±0.01 g/sm^3
Flow battery voltage	51.29±0.01 V

Fig. 8 Battery subject of examination

In Table1 are given results of measuring data before discharging of battery.

5.2. INTERPRETATION OF RESULTS

Table 1 Results obtained of measuring of electrolyte density, voltage and resistance of cells before discharge of battery

Number of cell	Electrolyte density (g/sm^3)	Voltage (V)	Resistance (mΩ)
1	1.250	2.335	2.474
2	1.249	2.335	1.745
3	1.071	2.209	3.151
4	1.254	2.335	1.847
5	1.235	2.335	1.716
6	1.246	2.332	1.789
7	1.107	2.218	2.844
8	1.240	2.337	1.657
9	1.232	2.328	1.870
10	1.243	2.223	1.581
11	0.855	2.100	1.996
12	1.250	2.338	1.589
13	1.245	2.336	1.645
14	1.246	2.332	1.813
15	1.238	2.334	1.601
16	1.251	2.334	1.635
17	1.263	2.301	1.826
18	1.054	2.205	3.491
19	0.894	2.214	4.577
20	1.266	2.337	1.768
21	1.135	2.222	2.474
22	1.124	2.229	2.804
23	1.259	2.342	1.761

In following figures we can see electrolyte density at the end of discharge Fig. 9 and its dependence of capacity during the measuring for every cell of battery Fig.10.

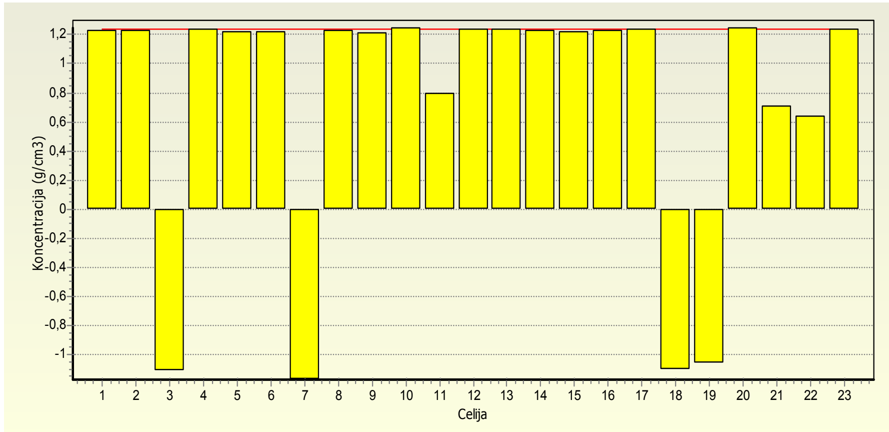

Fig. 9 Electrolyte density for every cell of battery at the end of discharge

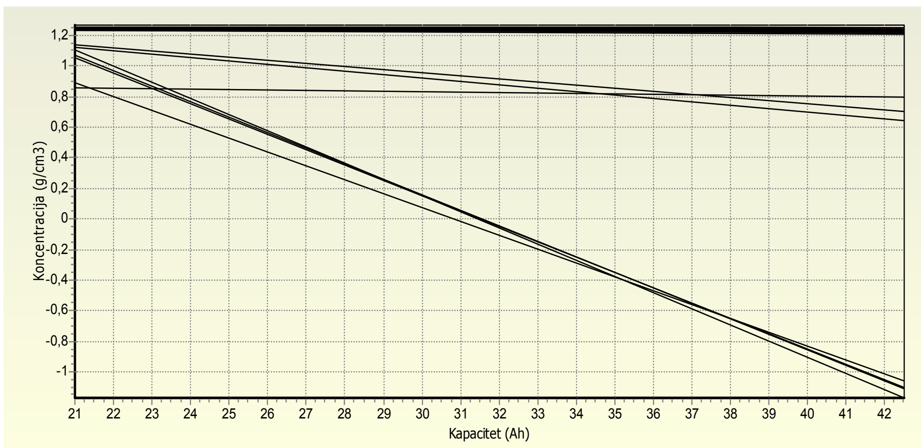

Fig. 10 Capacity for every cell of battery at the end of discharge

On Fig.11 and 12 is given resistance at the end of discharge an its dependence of capacity during the measurement for every cell of the battery.

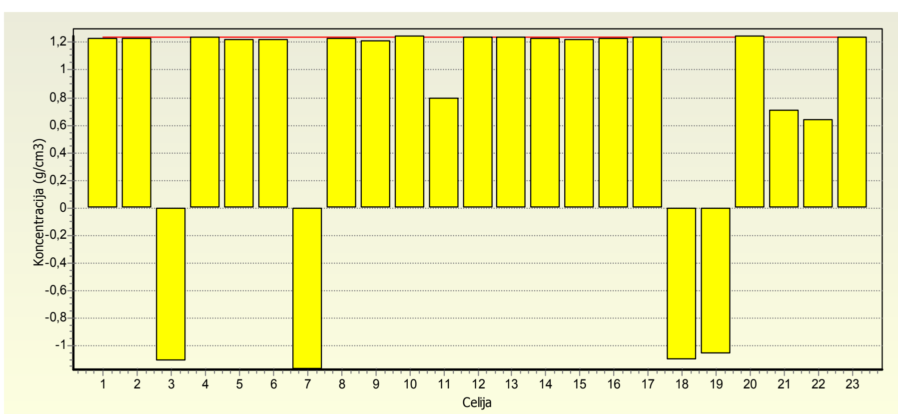

Fig. 11 Electrolyte density for every cell of battery at the end of discharge

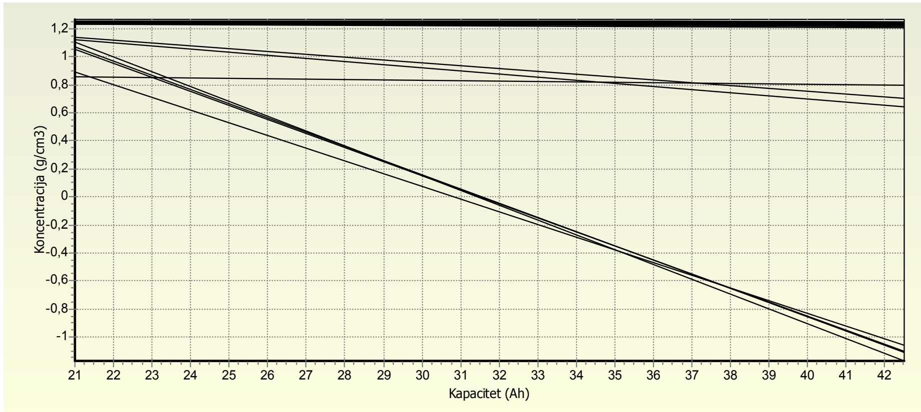

Fig. 12 Capacity for every cell of battery at the end of discharge

In figure 13 is given voltage at the end of discharge an its dependence of capacity during the measurement.

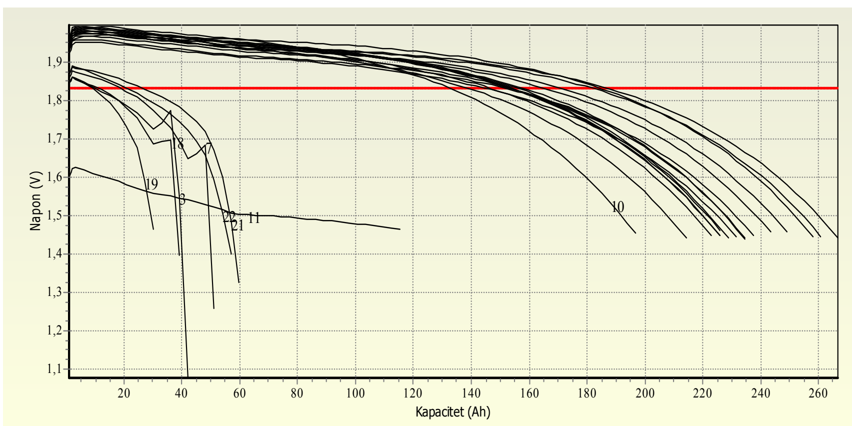

Fig. 13 Voltage for every cell of battery at the end of discharge

Also were measured capacity of each cell for current I=0.1C(%). On the base of the results, diagram is obtained and given to the Fig. 14.

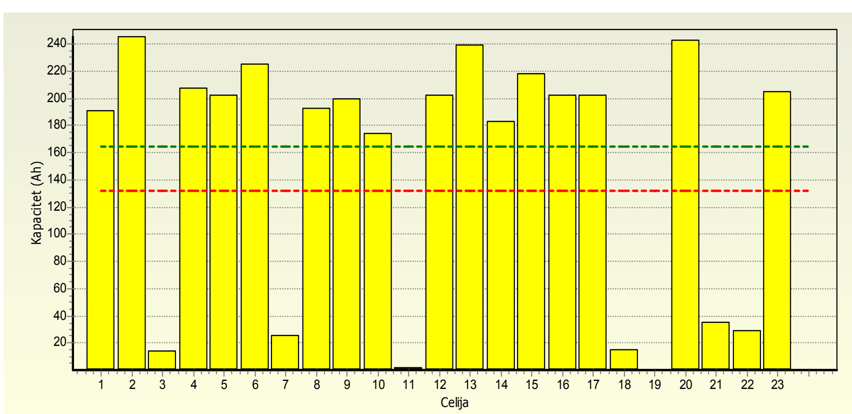

Fig. 14 Capacity of the cells at the end of discharge

5.2.1 ANALYSIS OF THE RESULTS

From previous measuring data and diagrams can be concluded that exanimate battery is in a very bad condition. It is necessary to replace it with new or at list replace the cells number 3, 7, 11, 18, 19, 21 and 22.

6. CONCLUSION

Because of its extreme importance, the UPS systems are integral and inevitable part of any power facility. Batteries are the most important element in the system for uninterrupted power supply. Up to them will be provided continuity emergency power and how it will last.

It is required at the very beginning, the correct choice and dimensioning of solid-state battery according provided working conditions, purpose and needs of customers that require providing security backup power and thus the required reliability of the system in terms of timely and continuous power consumers, as well as safety equipment and systems in general.

In addition to regular weekly audit and measure the voltage, the state of the electrolyte level, once a month is examined and the density of the electrolyte, necessary and regular annual capacitive tests. Capacitive sample test is recommended because revealing of the real situation. When the battery is at the end of life begins to significantly reduce the capacity (beneath 80% of nominal) and then need to be replaced.

This practical measurement shows that monitoring of batteries can increase a realibility of work and is necessary to detect any problem.

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